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WORKS**

WELCOME

GET YOUR **CURIOUS QUESTIONS** ANSWERED



Congratulations! Another issue of Brain Dump has been delivered direct to your tablet or smartphone. As usual, it's packed with facts, stats and info encompassing a fascinating range of topics from the worlds of science, space, nature, transport and the human body. Give your brain a workout and swipe left to get started.

The Braindump Team



SCIENCE



Why some are left-handed



SPACE



The nearest star-forming system



HISTORY



Why is gold so valuable?



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ENVIRONMENT



Why breaking waves are white



TECHNOLOGY



How do gun silencers work?

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A detailed photograph of a kingfisher in mid-dive. The bird is headfirst in the water, with its wings spread wide, showing the underside of the feathers. Its long, sharp beak is pointed towards a small, silvery fish just below the surface. The water is splashing around the bird's head and wings. The background is a calm, brownish-grey water surface. In the foreground, there are several smooth, dark grey and brown river stones.

THAT'S AMAZING

A common kingfisher shows us his hunting prowess as he dives headfirst for his prey. A kingfisher hunts by perching high up on a tree and then once it has spotted its dinner, elegantly diving down like an arrow into the water, at speeds of up to 60 kilometres (40 miles) an hour.

A close-up photograph of astronaut Scott Kelly. He is looking down at a small, clear, spherical object he is holding. Inside the sphere, there is a vibrant green, textured substance that resembles a dense forest or a microscopic organism. The background is blurred, showing other people in a space station environment.

THAT'S AMAZING

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Scott Kelly celebrates breaking the spaceflight record for spending the longest time in space, by playing with a floating ball of water and inserting coloured ink and an effervescent tablet into it.

THAT'S AMAZING

Glowing gas and dust lanes of the Trifid Nebula mingle in this stunning star-forming region. The Trifid Nebula is 300,000 years old, making it one of the youngest nebulae known. It lies at a distance of around 9,000 light years away and, in this image, spans about ten light years.





WHY IS GOLD SO VALUABLE?



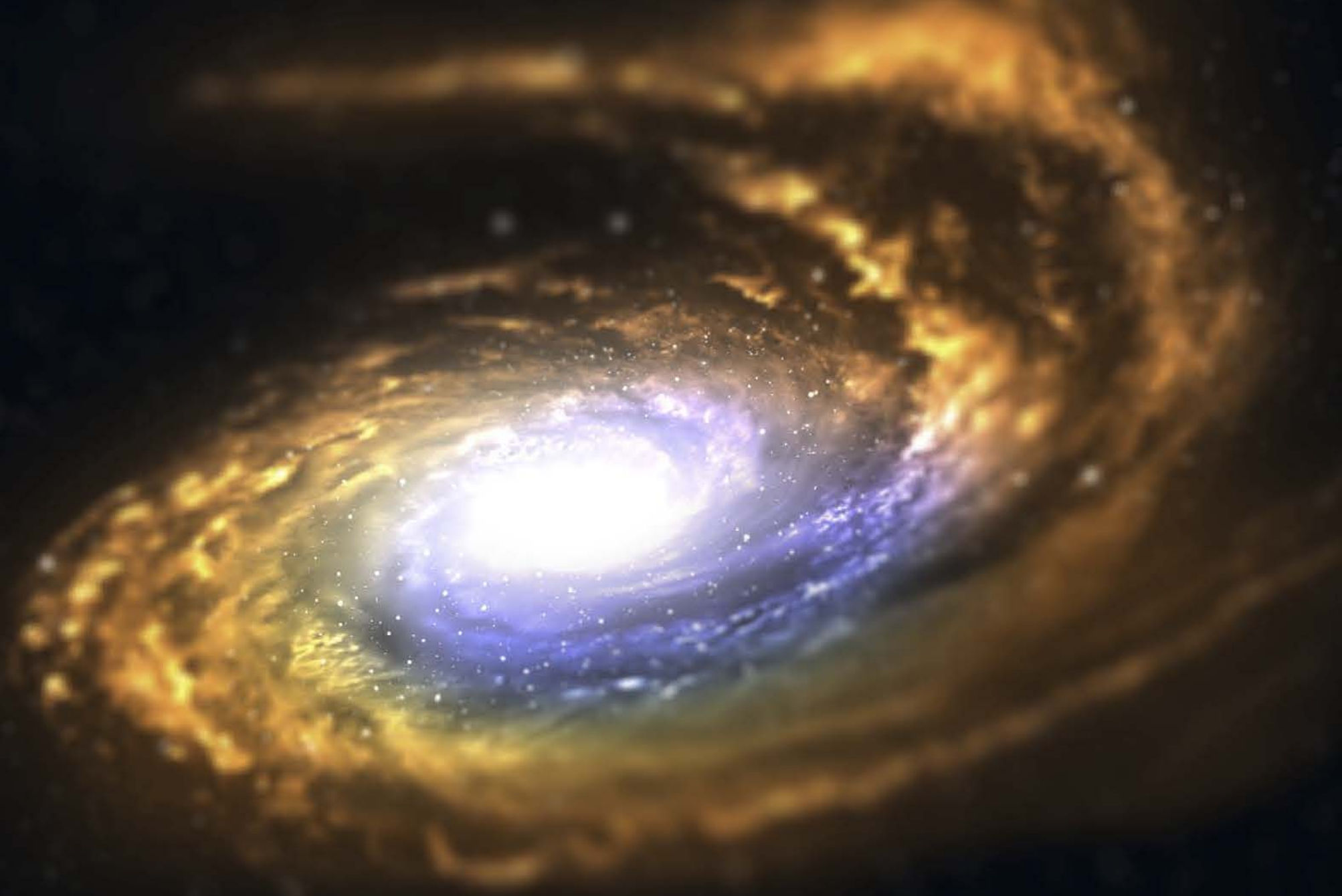
Gold has been prized throughout human history due to its scarcity, combined with a unique selection of properties that led to its use as a currency. Gold is rare, making up just five parts per billion of the Earth's crust. It is also difficult and expensive to extract, so only very limited quantities can be mined every year, making it a stable currency. Gold is remarkably unreactive and so does not oxidise like silver or iron. Therefore, gold coins do not lose or gain weight over time. Gold's malleability also allows it to be moulded into different shapes and divided easily.

HOW DOES A SILENCER ON A GUN WORK?



When a gun is fired, explosive gunpowder is ignited, creating a high-pressure pulse of gases, which forces the bullet down the barrel. It exits at a supersonic speed with a bang that breaks the sound barrier. A gun silencer suppresses that sound. The suppressor consists of a tube of small chambers separated by baffles, attached to the end of the barrel. When the gun is fired, the pressurised gas expands into lots of holes, so the pressure is far lower.

WHERE IS THE EDGE OF THE GALAXY?



Galaxies don't have exact boundaries, but ours has an approximate diameter of 100,000 to 120,000 light years and a thickness of about 1,000 light years. It is a barred spiral galaxy, and our Solar System is located at the edge of one of its four arms. Our Solar System orbits the

rotational centre of the Milky Way at about 250 kilometres (155 miles) per second, taking 200 to 250 million years to complete one orbit. Our Solar System is about 25,000 light years from the Galactic Centre. It's also estimated to be about 25,000 light years from the rim of the Milky Way.



COOL
THINGS

NORTHERN LIGHTS

- 1** A massive magnetic disturbance back in 1989 caused visible aurarae as far south as Texas, Florida and Cuba.
- 2** Amazingly, a phenomenal 99 per cent of visible matter in the universe is actually made up of plasma of one sort or another.
- 3** Other planets, including Jupiter, Saturn, Uranus and Neptune, and many of their moons, do in fact have their very own aurorae.
- 4** The massive electrical activity of the northern lights transmits rather eerie crackling and whistling noises over radio receivers.
- 5** The North and South Poles have switched places 400 times in the past 330 million years, the last occurrence being 780,000 years ago.



HOW DO CHAMELEONS CAMOUFLAGE THEMSELVES?



Certain species of chameleon have layers of cells called chromatophores, which contain different-coloured pigment granules; by moving these granules around, they control their colour. This technique is more commonly used as a method to signal emotions than camouflage; the species with the best colour-changing abilities use their talents to attract a mate rather than hide from predators. For most species of chameleon, camouflage works in a similar way to other animals; they have evolved over time to blend in with their surroundings. For example, the mottled colour and spiky shape of the brown leaf chameleon make it almost invisible among dead leaves.



HOW IS TEQUILA MADE?



Tequila originates from the blue agave plant, which can take between eight and ten years to fully mature. Once ripe and ready for harvesting, the agave's core, or 'piña', is extracted. A piña can weigh over 90 kilograms (200 pounds). Each litre (0.26 gallons) of tequila needs around seven kilograms (15 pounds) of it to produce.

At the distillery stage, the piña hearts are split open and roasted in large ovens to break their complex starches into sugars. The released liquid is

sealed within large steel vats for fermentation where yeast is added. Fermentation can last hours or days. The fermented juice will have a low alcohol content at this stage. To increase the volume of alcohol, it is distilled twice, by heating the liquid to alcohol's vaporisation point before cooling and condensing it. Purified water is added to dilute the tequila for a 40 per cent alcohol content. It is either bottled immediately or transferred to wooden barrels to age.



HOW
DOES

TRUTH SERUM WORK?

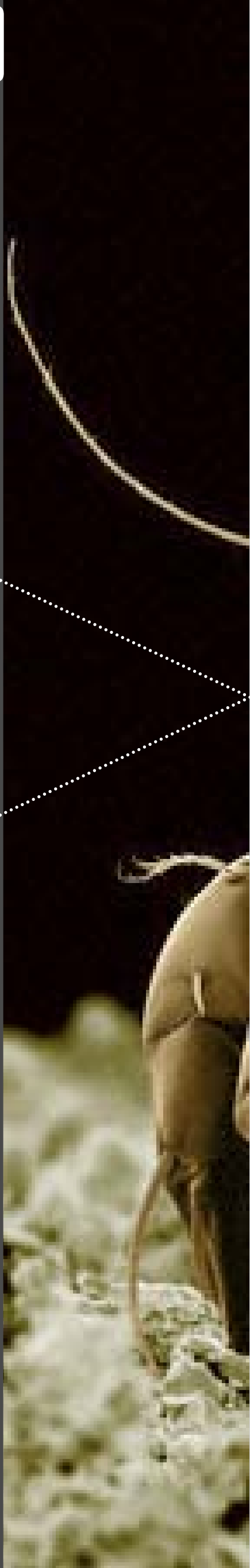


Many so-called truth serums are barbiturates, such as sodium thiopental, originally used as anaesthetics or sedatives. Similar to alcohol, they depress the central nervous system and impair judgement and cognitive function. Doctors observed that these drugs reduced inhibitions in patients, causing them to talk more freely. One theory is that by disrupting brain function, such drugs might make it more difficult for a suspect to concentrate enough to lie convincingly. But these drugs also tend to make people extremely suggestible and incoherent, so they are not reliable and don't stand up in court.

WHAT IS IT?



SWIPE TO REVEAL



A FLOUR MITE



These microscopic critters are pests that contaminate stored flour, grain and other food products. The mites are pale greyish-white in colour with pink legs. Males are 0.33–0.43mm long; females are 0.36–0.66mm long.



WHAT WILL HAPPEN

WHEN THE SUN DIES?



As the Sun begins the dying process, it will swell before exploding into a planetary nebula. In the coming few billion years, the Sun will gradually run out of hydrogen fuel and begin to fuse heavier elements. Its core will become denser while its outer layers grow hotter, expanding outward

and evaporating all of Earth's water. Eventually the Sun will be a hundred times bigger than it is now, engulfing Mercury, Venus and possibly Earth. When it eventually runs out of fuel, it will eject its material outward in an expanding shell of gas, leaving behind a superdense but dim white dwarf star.

HOW DO MONORAILS WORK?



Most monorail trains use wheels running over a single guide rail with horizontal wheels clamping it to the rail on either side, so the train doesn't fall. But some use maglev technology to float above the track. There are two main types: Electromagnetic suspension (EMS) uses C-shaped arms that wrap under the track; electromagnets pull the train up by attracting the arms to the bottom of the track. Electrodynamic suspension (EDS) uses the train's motion to induce magnetic eddy currents in the metal rail, that creates a cushion of magnetic repulsion. Maglev trains accelerate using magnetic coils built in to the side of the track.





WHY DO CATS LAND ON THEIR FEET?



When they take a tumble, cats move their front and back limbs separately to create spin (angular momentum) and right themselves in mid-air. This feat requires great flexibility. First, a falling cat uses its eyes and inner ear to work out which way is down. It then stretches out its hind legs while pulling in its front legs. Turning its rear end slightly one way, it twists its front end in the other direction until its front paws are facing down. From this position it tucks in its back legs and swivels them around, enabling it to stretch out all four limbs toward the ground.



WHY ARE SOME PEOPLE LEFT-HANDED?



Around ten per cent of the general population is left-handed, and according to archaeological evidence, this proportion has remained the same for around 5,000 years. A mathematical model developed by Northwestern University has a possible explanation.

Humans are a competitive species, and historically we fought hand-to-hand to settle disputes. In direct competition, left-handers have the advantage because their stance is unusual, and in one-on-one sports like fencing and baseball, there are many more left-handed athletes than you might expect.

If this were the only affecting factor, the numbers of left and right-handed

people would eventually even out. However, even more important to humans than competition is co-operation. As a social species, one of our defining characteristics is the use of tools.

Left-handed people are at a disadvantage when using tools that are designed for right-handed people, and in golf – a sport where there is no direct competition and a heavy reliance of specialist tools – left-handers are rather under-represented. This balance between the advantage of novelty in competition and the disadvantage of difference in co-operation is thought to be the reason that some of the population is left-handed.

WHERE'S THE NEAREST STAR-FORMING SYSTEM?



The closest bright star-forming nebula to Earth is the Great Orion Nebula, located about 1,350 light years away. There are other, fainter starbirth regions closer to our Solar System.

The closest known group of young stars is the TW Hydrae association, whose 30-plus members lie 175 light years away in the constellation of Hydra (the water snake). At roughly 5 million years old, several of these stars are still

growing by pulling in gas and dust from their surroundings.

A number of full-blown starbirth nebulas lie around 500 light years away in southern hemisphere constellations, such as Chamaeleon and Corona Australis. They appear dark as they are only generating low-mass, Sun-like stars; they lack the high-mass giants whose brilliant radiation lights up brighter nebulas like Orion.

HOW HEAVY IS A CLOUD?



If you consider the weight of the water droplets the average cloud contains, it weighs in at around 500 tons. Clouds are made up of tiny droplets of water or ice crystals, suspended in the air. On average, a cumulus-type cloud – the white, fluffy type – has a volume of one cubic kilometre (0.24 cubic miles), containing 0.5 grams (0.018 ounces) of water per cubic metre (35 cubic feet). This adds up to a total of 500 tons, although in reality this can vary significantly based on the size of the cloud. Despite this huge weight, clouds still float because the dryer air below them is denser.

NATURAL WONDERS

of the world

Life of a monarch butterfly

The butterfly king makes a
spectacular migration, guided by
instinct and an internal compass

SWIPE
FOR MORE



METAMORPHOSIS

The transformation from caterpillar to butterfly

1. Egg

Female monarchs lay their eggs on milkweed plants; before laying, the mother tastes the leaf to check it is suitable.

2. Larva

The larva hatches four days after the egg is laid. It eats the nutrient-rich eggshell followed by the milkweed leaf.

3. Caterpillar

The caterpillar munches voraciously on milkweed, growing to 5cm (2in) in length and around 3,000 times its original size in just two weeks.

4. Hanging J

The caterpillar attaches a wad of silk to a stem and hangs upside down in a 'J' position for about 18 hours.

5. Metamorphosis

Over a period of about ten to 14 days, the caterpillar transforms into a butterfly within this hard protective case.

6. Chrysalis (pupa) formation

The caterpillar's exoskeleton splits from the head upwards and the insect wriggles to discard it, leaving behind a perfect chrysalis.

7. Final stages

The green pupa becomes transparent one day just before the adult is ready to emerge.

8. Emergence

The adult monarch pushes its way out, grabbing on to the exoskeleton. Within minutes, its tiny folded wings grow to full size.

9. Flight preparation

A newly emerged butterfly waits about an hour for its wings to dry completely and become fully airworthy.

10. Take off!

The monarch finally spreads its wings and takes flight, ready to begin the cycle all over again.

“Between 60 million and 1 billion monarchs undertake an incredible winter migration”



WHAT'S THE DIFFERENCE BETWEEN A COMET AND AN ASTEROID?



Asteroids and comets orbit the Sun and are leftovers from the formation of our Solar System. Both are irregularly shaped and occasionally crash into Earth. Comets are mostly ice, and can be as big as 40 kilometres (25 miles) across. They form in the outer Solar System. Asteroids are rocky and

larger; they range from particle-sized to 1,000 kilometres (620 miles) across or more, and come from the Asteroid Belt. Comets partially melt and form tails as they get closer to the Sun, but asteroids are solid and stable. And while there are millions of asteroids, there are only about 4,000 known comets.

WHY IS ANTARCTICA A CONTINENT?



A continent is defined as a large, mostly continuous expanse of land, and although Antarctica is covered by a thick ice shelf, if you melted through it, it would reveal rocks, valleys and mountains. Antarctica is a landmass greater in size than both Europe and Australia, making it the fifth-largest continent on the planet. If

you did the same to the Arctic and removed the ice and snow, all that would be left is the Arctic Ocean, as there is no land hiding beneath. So while Antarctica is a continent surrounded by water, the Arctic is water surrounded by three continents: Europe, Asia, and North America. The Arctic and Antarctic are very different!

WHY DO DOGS LICK PEOPLE?



It's widely believed that dogs lick humans to show affection, but there are many other theories.

One is that salty sweat and food residue on our skin taste great. They also give an idea about where we've been and what we've eaten.

Puppies learn that licking is a way of communicating with other pack members. They will often lick to greet one another and strengthen bonds within the group. In adult dogs, licking is also a way of showing submissiveness to a dominant pack member, so it's likely that dogs lick us for the same reasons.

WHY DO BREAKING WAVES LOOK WHITE?



The white foamy surf we see in breaking waves is actually made up of lots of tiny droplets containing bubbles of air. These air bubbles do not absorb as much light as pure water droplets, so the light that has passed through them is brighter than the surrounding sea. This is what usually

gives surf its white appearance. This effect is more noticeable when seas are rough, as the churning waves produce more aeration and therefore more bubbles. Pollution or dissolved organic matter in the sea (often produced by the decay of algal blooms) can also create white foam along the shore.

AMAZING SCIENCE EXPERIMENTS

THAT YOU CAN DO AT HOME

Variables
What happens if you increase the temperature of the water or the amount of baking soda?



ERUPTING VOLCANO

EQUIPMENT

Plastic bottle
Baking soda
Washing-up liquid
Water
Red food colouring
Vinegar
Tray
Sand



1. Fill your bottle three quarters with warm water. Add two heaped tablespoons of baking soda before applying the lid and mixing the bottle until the soda dissolves.



2. Now add your red food colouring to the water, as well as a decent squirt of washing-up liquid, before mixing the bottle once more.



3. Put your tray on a flat surface before placing the bottle at the centre. Pile your sand up around it until you create a cone, with only a hole left at the bottle's neck.

4. Take your vinegar and pour it liberally into the top of the cone. The vinegar will fall down into the bottle and cause an eruption of red liquid to froth out and down the sides of the cone, just like a mini volcano.

WHAT HAVE YOU LEARNED?

The eruption of the mini volcano is caused by the bringing together of an acid and a base. The vinegar contains acetic acid and the baking soda sodium bicarbonate (a base). They react to produce sodium acetate (a salt), as well as carbonic acid. The latter product is key to the eruption, as carbonic acid breaks down in water into carbon dioxide, causing a gaseous frothing of the red solution up the inside of the bottle and out over the sides of the cone. This behaviour, according to the Brønsted definition of acids and bases, is because bases decrease the concentration of hydrogen ions by accepting them from acids, which themselves are defined by their ability to give them away. In our example, this was shown by the baking soda accepting the carbonic acid's hydrogen ions, causing it to rapidly decompose in the solution and release carbon dioxide.

THE OSHKOSH STRIKER

US COMPANY OSHKOSH'S MONSTER OF A FIRE ENGINE

1. CAMERAS

To concentrate the water cannons on the epicentre of a fire, infrared cameras are used from the safety of the cabin.

2. HULL-PIERCING CANNON

A optional 142cm (56in) spear called a "snozzle" of metal can be attached to pierce through aircraft in the event of hull fires.

3. CAB

Five people can clamber in but the Striker is so simple to use that it can be operated by one person.

4. FOAMING AGENT

The Striker comes equipped with 1,590l (420ga) of foaming agent and 11,356l (3,000ga) of water to extinguish the toughest infernos.

5. FIREFIGHTER PROTECTION

The crew are well protected by the glass windscreen, which offers panoramic views of very large infernos.

6. UNDERTRUCK NOZZLES

Fuel spills are a common issue in airports so six undertruck nozzles have been attached to spray foam 360 degrees.

7. LIGHTWEIGHT CHASSIS

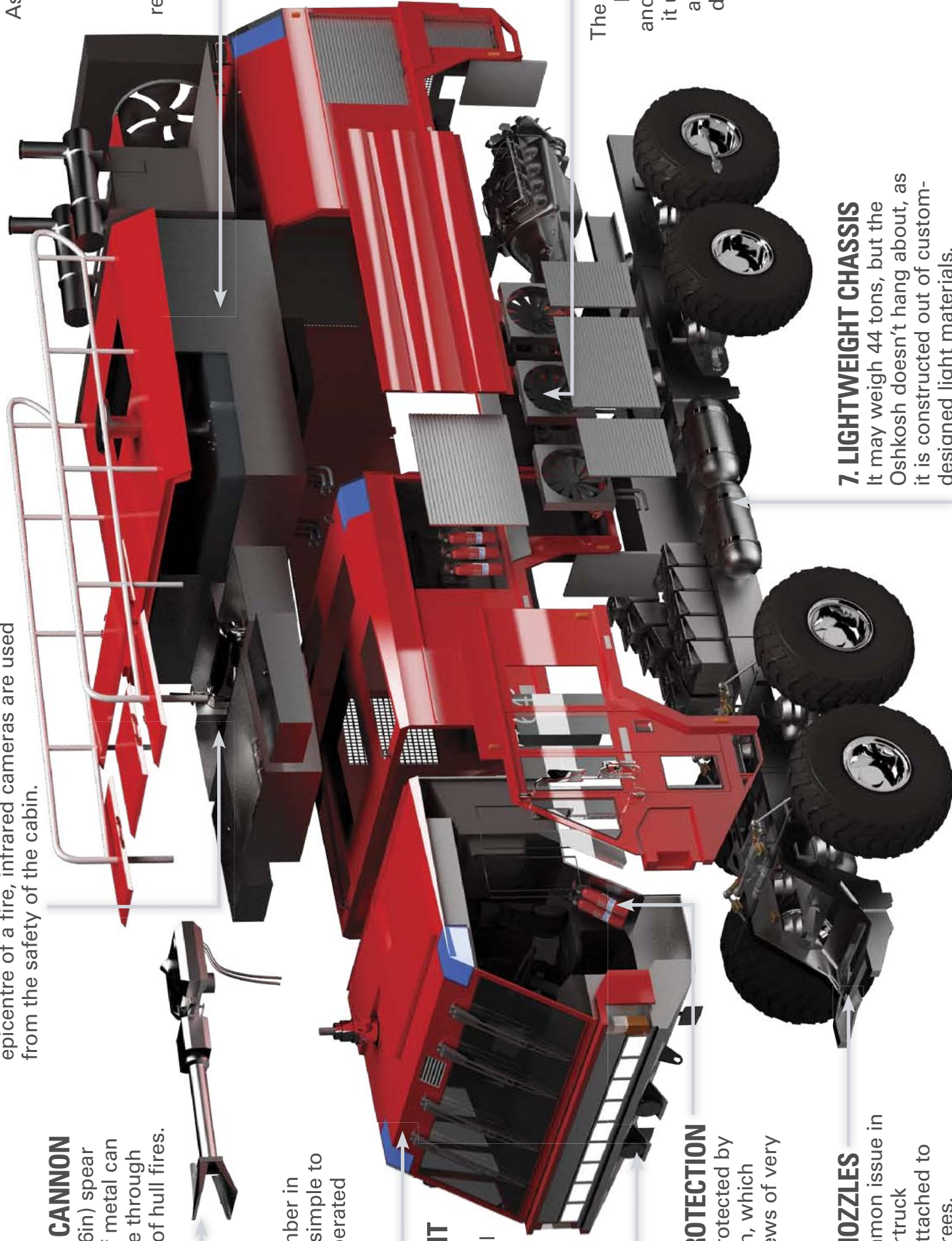
It may weigh 44 tons, but the Oshkosh doesn't hang about, as it is constructed out of custom-designed light materials.

8. ENGINE

The V8 engine powers both the drivetrain and the cannons, and it uses computers to adjust the power to different situations.

9. CHEMICAL TANK

As well as foam, the Striker holds high amounts of potassium bicarbonate to prevent oxidising reactions in the fire.



HOW TO

CREATE A LAVA LAMP



1 POUR IN SOME OIL

Empty and wash out a clear plastic bottle, then fill it until it is about three-quarters full with vegetable oil. Oil is nonpolar, which means its molecules have neither a negative nor positive charge. The molecules are also not packed very tightly together, meaning the liquid is not very dense. Both of these factors are important for creating the lava-lamp effect as they cause the oil to react in an unusual way with the next ingredient.



2 ADD WATER AND COLOURING

Fill the bottle with water and a few drops of dark food colouring. It will sink to the bottom because its molecules are packed more tightly together, making it denser than the oil. Each water molecule has two positively charged hydrogen atoms and one negatively charged oxygen atom, so it's polar and will attract the opposite charge of other molecules. As oil molecules are nonpolar and have no charge, the two remain separate.

3 CREATE SOME FIZZ

Break up an Alka-Seltzer or other form of effervescent tablet into small pieces and drop them into the container. The citric acid and sodium carbonate in the tablet will react with the water to form sodium citrate and carbon dioxide gas. These gas bubbles stick to the water and travel upward because they are less dense than the oil. When they reach the top, the bubbles will pop, allowing the carbon dioxide gas to escape and the dense water to sink back down to the bottom.



IN SUMMARY...

This fun experiment is a great way to learn about density and polarity. To create a permanent lava lamp, you'll need two liquids with much more similar densities and a powerful lamp to heat up the denser liquid so that it rises and then falls again when it cools down.

MISSION COST
\$3.26BN

DATA CAPTURED

300GB

7

NEW
SATURNIAN
MOONS
IDENTIFIED

STATISTICI/COOL

CASSINI MISSION

PHOTOS TAKEN TO DATE:

300,000

12 KM
LENGTH OF
CASSINI'S
WIRES

1655
YEAR OF TITAN'S DISCOVERY